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Cardiff School of Sport

DISSERTATION ASSESSMENT PROFORMA:

Empirical [1]

Student name:	Nia Cerys Morgans	***Student ID:***	ST20008197
Programme:	SCRAM		
Dissertation title:	The Effects of Kinesiology Tape and Conventional Rigid Tape on Star Excursion Balance Test Performance		
Supervisor:	Adeline Phillips		

Comments	**Section**
	Title and Abstract (5%) Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the empirical study undertaken.
	Introduction and literature review (25%) To include: outline of context (theoretical/conceptual/applied) for the question; analysis of findings of previous related research including gaps in the literature and relevant contributions; logical flow to, and clear presentation of the research problem/ question; an indication of any research expectations, (i.e., hypotheses if applicable).
	Methods and Research Design (15%) To include: details of the research design and justification for the methods applied; participant details; comprehensive replicable protocol.
	Results and Analysis (15%) [2] To include: description and justification of data treatment/ data analysis procedures; appropriate presentation of analysed data within text and in tables or figures; description of critical findings.
	Discussion and Conclusions (30%) [2] To include: collation of information and ideas and evaluation of those ideas relative to the extant literature/concept/theory and research question/problem; adoption of a personal position on the study by linking and combining different elements of the data reported; discussion of the real-life impact of your research findings for coaches and/or practitioners (i.e. practical implications); discussion of the limitations and a critical reflection of the approach/process adopted; and indication of potential improvements and future developments building on the study; and a conclusion which summarises the relationship between the research question and the major findings.
	Presentation (10%) To include: academic writing style; depth, scope and accuracy of referencing in the text and final reference list; clarity in organisation, formatting and visual presentation

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CARDIFF METROPOLITAN UNIVERSITY
Prifysgol Fetropolitan Caerdydd

CARDIFF SCHOOL OF SPORT

DEGREE OF BACHELOR OF SCIENCE (HONOURS)

SPORT CONDITIONING, REHABILITATION AND MASSAGE

2014-5

The Effects of Kinesiology Tape and Conventional Rigid Tape on Star Excursion Balance Test Performance

Dissertation submitted under the discipline of SCRAM

Nia Cerys Morgans

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The Effects of Kinesiology Tape and Conventional Rigid Tape on Star Excursion Balance Test Performance

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Abstract

To identify whether conventional rigid tape or kinesiology tape had an effect on the Star Excursion Balance Test (SEBT) within female hockey players. It was hypothesised that a substantial difference should be seen in respect to the distance achieved on the SEBT when using kinesiology tape compared to conventional rigid tape. A squad of female hockey players from Cardiff Metropolitan University participated within the study (N = 16). The study utilised a single group, all completed the SEBT under three different protocols, three times for each protocol, on three separate days. There tests were carried out with 24 hours between each day to limit familiarisation and improving through practice. The SEBT was used to measure the participants' dynamic balance by reaching out in eight different directions and measuring the distance. A closed basket weave taping measure was the chosen method of taping for the conventional rigid tape whereas kinesiology tape used three strips which followed the lateral ligaments of the ankle. Subjects were barefooted, and their dominant leg was used as the stance leg and hence, the taped leg. Results demonstrated that, excluding one direction; medial, a further mean reach distance was achieved with kinesiology tape. Also exclusive of two directions; anterior and posteromedial, a shorter mean distance was produced from rigid tape. Repeated-measures ANOVA was executed to determine whether the mean distances achieved were significant. Results of the ANOVA indicated that there was a significant difference in two groups; lateral and posterolateral ($p< 0.05$). In addition to this, a Bonferroni post-hoc test revealed the significant difference arose between; no tape and kinesiology tape ($p = 0.047$) in the posterolateral direction and rigid tape and kinesiology tape ($p = 0.020$) within the lateral direction. Differences can be identified for the reaching distances between conventional rigid tape, kinesiology tape and no tape within the different directions of the SEBT. While the patterns have been identified, further research is needed to increase the statistical power of the study by broadening the subject area to develop a sound underpinning of the effects of the tape and in turn, their effect on balance.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Field Hockey is a highly admired sport, played across the globe by all ages and genders (Murtaugh, 2001). Hockey is a physically demanding sport, involving high acceleration/deceleration, change of direction speed and overall, high work load (Murtaugh, 2001; Naicker *et al.*, 2007). Despite the sports' popularity, injury rates are increasing, from minor injuries; such as contusions and sprains to more serious injuries; torn ligaments and concussions (Murtaugh, 2001). Research of sporting injuries are vital, for both performers and coaches to understand the mechanisms of injury, and injury recovery, including potential new theories. Ankle sprains are established as the most common injury, lateral ligament ankle sprain more regular than most (Murtaugh, 2001). It has been established that there are predisposing factors that can increase the risk of injury/re-injury (Naicker *et al.*, 2007; Zemková, 2014). These predisposing factors can come from; external agents (McKay *et al.*, 2001; Beschorner and Cham, 2008); opponents, surface, footwear, amongst others, or internal agents; proprioception, stability and overall balance (Naicker *et al.*, 2007; Beschorner and Cham, 2008; Ogard, 2011).

Balance can be broken down into two components; dynamic or static balance (Foran, 2001). Dynamic balance is used in sport, and it is imperative that a body is balanced prior to performing a skill to obtain the correct movement (Forna, 2001, Zemková, 2014). Balance, both static and dynamic balance involves completion of a task without compromising one's base of support; and in contrast; stability (Hesari, 2013). The SEBT required the participants to produce a maximum research outside of the base of control and then return to equilibrium in eight different directions.

Sports' taping is a relatively new protocol incorporated into practice, used for recovery from injury and possibly injury prevention (Hussain, 2010). Ankle tape is used commonly within sport as an external agent to restrict and control excessive movements (Knight and Weimar, 2012).

CHAPTER TWO: LITERATURE REVIEW

2.1 Balance and Stability

During performance an athlete predominantly uses two different types of balance; static balance, defined as the body's ability to maintain a hold with no functional movement (Foran, 2001), and dynamic balance, described as the ability to perform a task or movement and have the capability to return to a stable position (Foran, 2001). Against the backdrop of a sport specific setting, Foran (2001) describes dynamic balance as a personal ability to refine and control movements in order to perform a skill effectively. Wesson *et al.* (2005) simplifies balance as a body's ability to maintain its' centre of mass over the base of support. McGinnis (2003) states after displacing an object, it has the capacity to return back to equilibrium or its original position. In the sporting world, balance is an significant factor which underpins performance with rapid changes of direction and readjustment of balance with different skills (Zemková, 2014). Zemková (2014) suggests that impairment with an athlete's balance cannot only become a limiting factor within sport, but can also increase the risk of injury or re-injury to that athlete. There are many factors that can contribute to a persons' balance, some may be environmental, others human factors (Beschorner and Cham, 2008). Beschorner and Cham (2008) highlight footwear as an environmental factor due to their support of the foot and ankle joint along with the material and frictional properties. Human factors come from within the body; including muscle mechanisms, cognitive processes and neuro-sensorimotor methods that are all coordinated for awareness of proprioception (Beschorner and Cham, 2008). These factors are also used in the recognition, detection and recovery of perturbation from an outside object or instability from within (Beschorner and Cham, 2008). Thus, a body firstly detects a change occurring which results in a loss of balance. Secondly the body must generate a fast and effective postural response to recover and re-establish balance and consequently enables continuous movement (Beschorner and Cham, 2008).

A body's neuromuscular control and prorioceptive ability is a major component of balance. Myers *et al.*, (1999) conducted a study to understand the difference between these two variables within balance. Neuromuscular control is the body's involuntary response from a stimulus creating a primary impulse along the motor nerve (Myers *et al.*, 1999). This impulse is sent to the central nervous system to form secondary reactive pathway along which sensory information is sent to create a reaction or movement. Furthermore, proprioception is a specific constituent of touch which includes a sensory modality that comprises of kinaesthesia as joint movement and position (Myers *et al.*, 1999; Ogard, 2011). Ogard (2011) defines the body's ability to sense action and location as proprioception including positional awareness, speed, velocity, muscular effort, exertion and finally displacement. This works in conjunction with balance as an athlete's body requires awareness and the ability to sense a displacement to readjust and counteract a movement to stay stable and in effect, balanced (Ogard, 2011). Ogard (2011) suggests that sensory input from visual systems along with vestibular and somatosensory input aid dynamic balance during motion. Consequently, a disruption to any one of these components may cause loss of information resulting in a challenge to maintain stability and normal movement, and may eventually cause injury (Ogard, 2011).

2.2 Hockey

Field hockey is a world renowned popular sport, enjoyed by both males and females (Murtaugh, 2001; Naicker *et al.*, 2007). A typical game consists of rapid acceleration/deceleration with stop-start movements, fast changes of directions and concise sprints with high-intensity movement patterns (Murtaugh, 2001; Naicker *et al.*, 2007). Historically it has been played on numerous surfaces, but is now mainly played on an artificial synthetic surface (Murtaugh, 2001; Naicker *et al.*, 2007). Recent literature suggests that most injuries are minor within the game; however, most commonly within the lower limbs and are often recorded as ankle sprains (Murtaugh, 2001; Naicker *et al.*, 2007; Murtaugh, 2009). A study by McKay *et al.* (2001) supported this proposal, suggesting ankle injuries within the sport occur at a rate of 3.85 per 1000 participants.

The primary mechanisms of lateral ankle sprains are from excessive inversion and plantarflexion movements (Hertel, 2002).Theorists such as Hertel (2002) and Hopper *et al.* (2009) describe in literature how the most common predisposition of recurring ankle sprains are from previous sprains occurring as a result of mechanical or functional instability. Mechanical instability is defined from changes in laxity with the support system and ligaments, movement of joints and bone surfaces, irritation within the joint or all round degenerative changes (Hertel, 2002). Insufficiencies with neuromuscular control and proprioception are functional instabilities (Hertel, 2002). A combination of these two phenomena can result in chronic instability (Hertel, 2002).

Naicker *et al.* (2007) developed a study to determine the incidence of injuries using three female hockey squads from KwaZulu-Natal (KZN), South Africa; U19, U21 and the senior provincial squad. The players underwent different procedures from laboratory testing to completing surveys and questionnaires, with Naicker *et al.* (2007). Furthermore, linking results and injury rates to other variables; position, level and number of years playing. Additional studies have been conducted extensively reviewing types of injuries, with injury rates and player positions producing a significant correlation (Tucker, 1997). Naicker *et al.*'s (2007) results showed that injury was most frequent with players reaching national level and having played for six to seven years, with a larger injury rate for those who play in multiple positions; forward and link positions. The study also delved into the mechanisms and severity of ankle injuries sustained during the 2004 season. At 60% of all incidents, a fall was found to be the highest mechanism of injury, all of which were reported as lateral ligament sprains during a game (Murtaugh, 2001; Naicker *et al.*, 2007; Hopper *et al.*, 2009). The severity of each ankle sprain differed between individuals with 50% of ankle injuries being kept 'away from sport' for two-four weeks, 33% for one-two weeks and as little as 16.7% unable to play for six-eight weeks (Naicker *et al.*, 2007). From these statistics, Naicker *et al.* (2007) proposed that a predisposing factor for ankle injuries within female hockey is a result of poor proprioceptive ability due to low scores on a balance board; supporting the decision to test propriocetive and stability skills, hence balance, within this current study.

McKay *et al.* (2001) studied sports players to confirm three risk factors linked to ankle injuries; a history of weaknesses in the lower limb, specific shoes type with air cells and lack of muscular preparation prior to beginning performing increased the chance of injury by 2.6%. From recent years, it is also mentioned from thorough investigation on lower limb injuries and rehabilitation for the return to sport, treatment and the management protocol has dramatically changed incorporating new products such as sports taping (Hussain, 2010).

2.3 Tape

Within many teams and major events, multidisciplinary teams are vital for on hand support with all trauma, recovery and prevention. A display of such support was evident in the 2012 London Olympic Games Polyclinic saw over 2000 medical encounters within the physiotherapy service (Steffen and Engebretsen, 2014). Unique skills and techniques are practiced and modified by physiotherapists and medical personnel alike to help the recovery and in some cases, the prevention of an injury (Steffen and Engebretsen, 2014; Timpka *et al.*, 2014). A development in the sports industry as an injury preventative and post-injury rehabilitation measure is athletic tape (Bandyopadhyay and Mahapatra, 2012). Through research, it has been proposed that taping helps to support and reposition joints and both aid and reduce muscle movement and further prevent injuries (Kneeshaw, 2002; Morris *et al.*, 2013). Further detail prevailed that proprioception can also be enhanced due to increased stimulation of the cutaneous mechanoreceptors (Raymond *et al.*, 2012). It is also suggested that the neuromuscular system and posture, balance, management of pain and biomechanical enhancement could benefit from sports taping (Bandyopadhyay and Mahapatra, 2012). This taping trend underwent scrutiny and thorough research by McKay *et al.* (2001), with results proving that players with a history of ankle injuries have a lower probability of ankle re-injury with their ankle taped. While Bandyopadhyay and Mahapatra (2012) agreed with this theory, the pair emphasised that each body part and limb was to be strapped correctly following an appropriate procedure to achieve the desired outcome. Bandyopadhyay and Mahapatra (2012) established that rules, guidelines and certain principles such as; choosing appropriate tape, what type of application and how much tension should be applied would differ depending on the desired effect or outcome; rehabilitation, injury prevention, or improving performance (Bandyopadhyay and Mahapatra, 2012).

2.3.1 Rigid Tape

More often than not, zinc oxide is the preferred inelastic tape used by sports therapists to stabilise a joint and limit movement (Norris, 2004). This conventional rigid tape is frequently utilised with non-contractile tissue, which then acts similarly to a ligament to limit movement and prevents joints moving into dangerous or end range positions whereby common injuries occur (Klawon, 2010; Keil, 2012). Zinc oxide is fixed to the skin with strong adhesive, is slightly air permeable which allows the skin to breath and moisture to seep through (Norris, 2004). However, the composition of this rigid tape can be affected by certain human traits which prevents skin contact (Norris, 2004); body heat, moisture and sweat where by the tape can lose its tackiness and become ineffective, thus, the restriction of movements is lost (Norris, 2004). The strength of rigid tape is dependent upon its thread count; however, the tape can be correctly layered and intertwined to enhance and increase the strength on a joint, thus improving its overall effectiveness (Norris, 2004). Caution must be taken when using rigid tape with athletes as irritation could be caused as strong adhesive is used with zinc oxide to create a strong bond between the skin and the tape (Norris, 2004). Another method of irritation could be caused if the tape starts to pull on the skin and cause friction, if friction occurs, then the tape 'burns' the skin (Norris, 2004). Underwrap could be used to prevent such friction and reduce irritation occurring; however, the decreased contact between the skin and the tape results in decreased effectiveness of the tape (Norris, 2004). In addition to this, pressure points could be formed if the tape is applied incorrectly, either too tightly or taped over body landmarks (Norris, 2004). Similarly, less contact occurs when the taped area is covered in hair, and so methods could be taken to reduce this, by shaving the area (Norris, 2004).

Rigid tape is used as a temporary procedure to reinforce the muscle or ligament during movements to relieve stress from the injured area, and reduce movement (Norris, 2004; Keil, 2012). Keil (2012) found that using conventional rigid tape decreased movement patters by 35%, and so results in less injury reoccurring. This effect is suggested as a result of the conventional tapes' non-elasticity and stiffness (Klawon, 2010), and more force is required to displace the joint (Norris, 2004). For example; the mechanism for lateral ankle sprains are excessive plantar flexion and inversion movements (Hardy *et al.*, 2008). Commonly, to support this type of injury with taping, an enclosed ankle taping technique is used where adhesive tape restricts the ankle of an inward motion (Wilkerson, 2002; Hopper *et al.*, 2009). While this may be the case; different techniques of taping and the amount of tension applied will affect the joint and change the degree of movement (Hardy *et al.*, 2008). Thus, more tension applied to the joint by the external tape, increases the amount of force needed to result in injury (Norris, 2004). However, prolonged tension applied to the tape will result in fatigue of the tape itself and therefore become useless (Norris, 2004).

Kneeshaw (2002) proposes that taping is a widely used commodity and found that the consensus for the tape and its' benefits was of a general acceptance with practitioners and patients alike despite conflicting evidence of its efficacy. Perlau, Frank and Fick (1995) confirmed that rigid tape improved proprioception where as Kneeshaw (2002) established that ankles post taping had an increase in stability. Kneeshaw (2002) also discussed that rigid tape improves and stimulates neuromuscular pathways. Performers could find this information crucial as a combination of taping with specific training could further assist neuromuscular responses, hence improve performance (Kneeshaw, 2002). It has been established through research, that using conventional tape provides support to the joint and encourages muscle activation when compared to other sporting aids; braces (Keil, 2012). There are other functional effects from tape; learning process due to skin drag and increase proprioception (Norris, 2004). This proprioception is from a body's awareness of the tape anchoring the foot into place (Norris, 2004). A study by Robbins, Waked and Rappel (1995) confirmed improvement in proprioception when using tape, and additionally, a decreased effect when wearing footwear.

Sawkins *et al.* (2007) reported that of 45% of all injuries occur at the ankle joint, which supported previous research. However, while Sawkins *et al.* (2007) found that ankle taping supported an unstable ankle, there was no sound evidence seen from the research that ankle taping prevented an injury. During this study, it was also seen that the significance of the tape and its restriction was reduced from as little as 10 minutes of exercise hence rendering the tape of little use (Sawkins *et al.*, 2007). Both Klawon (2010) and Keil (2012) supported Sawkins *et al.*'s (2007) literature, suggesting that inelastic tape should only be used during one activity session as it loses it structural properties, whereas Keil (2012) also reported that rigid tape lost 14 % stability after 30 minutes.

Sawkins *et al.* (2007) also found conflicting evidence in that while taping uninjured athletes who had no history of sprains showed a positive result of tape improving active joint positioning and aiding with balance and stability, athletes with reoccurring ankle sprains showed no effect from taping. Justifiably, Sawkins *et al.* (2007) gave the statement that taping to increase and enhance proprioception in the prevention of ankle sprains debatable. Furthering this, Sawkins *et al.* (2007) suggested that the tape improved performance due to a confidence boost, as the athlete believed the tape would prevent an injury and therefore proposed a study to test the placebo effects of rigid tape and a placebo tape, with the results showing no difference between the two tapes. From Kneeshaw (2002) research, it is suggested that the specific interaction between joints and tape is inconclusive; nevertheless, most theorists suggest mechanical properties and some propioceptive improvements with more effects being of psychological nature (Hume and Gerrard, 1998; Kneeshaw, 2002).

While positives have been established for rigid tape, evidence has suggested that this form of taping is becoming a disadvantage, decreasing capability and intensity of their performance (Sawkins *et al.*, 2007; Bandyopadhyay and Mahapatra, 2012). Along with the conflicting evidence to support tape, it has been seen that rigid tape limits the range of motion when applied to a joint and decreases inversion and eversion when applied to the ankle (Paulson and Braun, 2014). Furthermore, no empirical evidence has been found regarding this effect on stability and proprioception, leading areas for further research (Paulson and Braun, 2014). Respectively, Raymond *et al.* (2012) completed a review of literature to understand the effect of tape on proprioception with results being inconclusive and varied as proprioceptive sensations were reported as improving, having no change (Refshauge, Kilbreath and Raymond, 2000) and in some cases worsening and decreasing proprioception (Refshauge *et al.*, 2009).

2.3.2 Kinesiology Tape

Dr Kenso Kase, a Japanese Chiropractor, was first thought to have developed an elastic therapeutic tape called kinesio tape (KT) in the 1970s (Williams *et al.*, 2012). Kase developed this elastic tape for the treatment of sports injuries and other musculoskeletal conditions and contractile tissues (Norris, 2004; Williams *et al.*, 2012). Kinesio tape is a hypoallergenic breathable elastic tape which differs from

other more conventional tapes as it has the capability to stretch up to 140-180% from its resting length (Murray, 2000; Rocktape, 2009; Fratocchi *et al.*, 2012). As a result, a constant force is applied onto the skin resulting in a compressive force between the tape and the skin, and so, pulls on the skin (Norris, 2004; Fratocchi *et al.*, 2012). KT was created to yield many different effects; to relieve pain through control of neurological systems; improve lymph and blood circulation around the body by eliminating tissue fluid or bleeding beneath the skin through muscle movement; correcting muscle function by strengthening weak muscles; correcting misalignment of joints by relieving muscle spasm (Fratocchi *et al.*, 2012). This research was published in support of Klawons' (2010) earlier findings, as he also suggested that KT had therapeutic claims such as improving proprioception and accelerating the body's healing process as a result of increased blood flow to the area. Additionally KT differs from conventional tape not only with its tensile properties but also with its wear-ability. Its benefits include; durability to be worn from three to five days and it is waterproof meaning longer lasting benefits, and use within water (Klawon, 2010).
These developments soon became accepted in the sporting community and used by practitioners world-wide due to publicity within the 2008 Olympic Games with 58 countries (Klawon, 2010; Williams *et al.*, 2012). This method of taping is utilised when there is a need for support within abnormal structures, injuries and pain (Williams *et al.*, 2012).

This fairly recent development of KT and its technique is thought to help athletes recover faster from major injuries and enable them to work through minor, less damaging injuries with little or no pain (Bandyopadhyay and Mahapatra, 2012). It is suggested that KT lifts the skin away from surrounding muscles, while also supporting joints and the muscles itself; in turn, helping to relieve pain by increasing fluid movement to the immediate area (Williams *et al.*, 2012). Franettovic-Smith, Coates and Creaby (2014) suggested that within the elastic tape, the different fibres used to produce the material holds a waterproof element, which may lead to increased comfort and longer lasting use with the tape. Consequently, these factors could potentially be the reason for the increased popularity of the tape. It is suggested that the 'pull' produced by KT on the skin, will initiate a cutaneous reflex stimulation; muscle contraction, which in turn will stimulate mechanoreceptors and proprioceptive reflexes (Darton, Lippold and Shahani, 1985). As a result of these receptors, a neural message is apparent to the body, reminding the athlete of overstretching or joint position sense, which could be useful within the first stages of rehabilitation (Norris, 2004).

Three articles underwent scrutiny from Bassett *et al.* (2010) to report the effectiveness of KT on musculoskeletal pathologies; however, all of the studies reviewed found that the tape was ineffective (Williams *et al.*, 2012). Williams *et al.* (2012) published literature concerning the merit of KT improving proprioception, preventing/assisting rehabilitation for injuries, and to further find the potential for the use of KT with practitioners and athletes alike. Williams *et al.* (2012) developed the literature review from 10 articles that matched inclusion criteria to compare the effects of KT on injured athletes and the healthy population to explore any similarities or differences. Additionally, the review tried to find the efficacy of KT in the prevention and treatment of injuries (Williams *et al.*, 2012). It was found by Williams *et al.* (2012) that KT had a positive effect on injured musculoskeletal areas with strength training, active range of motion and force sense error. However, certain negative aspects were found, these suggested that with the studies reviewed, there was limited significant empirical evidence for the use of KT in other musculoskeletal variables; proprioception, muscular activity or pain.

2.4 Comparison of Tapes

The tapes themselves; rigid and kinesiology, both have different properties and work in dissimilar ways (Norris, 2004). Rigid tape is inelastic and has a strength function, compared to kinesiology, where by the tape itself it hypoallergenic, waterproof and elastic (Norris, 2004). Contrast to rigid tape, KT can maintain its function and be worn for a maximum five days (Klawon, 2010), whereas the function of rigid tape decreases over time and activity load (Norris, 2004). A recent study published by Franettovic-Smith, Coates and Creaby (2014) tested the results of exercise when working in conjunction with tape, for the management of exercise related leg pain. The study used a group of 45 female participants, aging from 18 to 40 years old for a six week intervention period to test the effectiveness of rigid anti-pronation tape compared to elastic anti-pronation tape during exercise. As a result of the study, it is evident that the taping procedures produced no effect in the management of injury

and the intervention of pain however, the consensus was that post strength training rest was preferred throughout (Francettovic Smith, Coates and Creaby, 2014).
A study comprised by Abián-Vicén *et al.* (2009) tested the differences between inelastic tape and elastic tape on the ankle joint range of movement; the findings suggested that there was no significant difference in the ranges of motion, apart from that in plantar flexion. While there was no significant difference between each tape, inelastic tape was seen to be more restrictive than elastic tape, with the subjects agreeing that elastic tape was more comfortable and less limiting to movement (Abián-Vicén *et al.*, 2009). Another disadvantage found from the study was that inelastic rigid tape fatigued, with the effects of the tape reduced at 20 minutes of exercise (Abián-Vicén *et al.*, 2009); thus, agreeing with research by Sawkins *et al.* (2007).

2.5 Star Excursion Balance Test

Ankle instabilities are barriers for athletes aiming to recover from injury, with it also being a significant factor for re-injury (Olmsted *et al.*, 2002). Olmsted *et al.* (2002) found that ankle instability had been thoroughly assed in research using static balance assessments; however, limited research was found on more dynamic tasks. With this, Olmsted *et al.* (2002) proposed a lower extremity reach test; the Star Excursion Balance Test (SEBT), to test whether deficits can be seen in subjects with chronic ankle instability. Later research found that the SEBT is used clinically by physiotherapists and rehabilitators and in research settings alike, to determine a patient's pathology or condition in the lower extremities; ankle instability (Gribble *et al.*, 2013).

The SEBT is a closed-kinetic chain exercise, where eight increments are taped to the floor, each at 45 degree angles apart. The participants' movements are tested in eight different direction; anterior (A), posterior (P), medial (M), lateral (L), anteromedial (AM), posteromedial (PM), posterolateral (PL) and anterolateral (AL) with respect to a stance leg (Earl and Hertel, 2001). The test required the participants to sustain a base of support through their dominant leg, and perform reaching tasks with the other through the eight directions, gently touching the floor, without compromising the support leg (Earl and Hertel, 2001; Gribble and Hertel, 2003). Maintaining the hold and controlling the movements challenges dynamic balance (Munro and Herrington, 2010; Hardy *et al.*, 2008). Munro and Herrington (2010) determined that a suitable amount of strength, proprioception and neuromuscular control along with sufficient range of movement in the lower limbs and joints are needed to perform the test. Earl and Hertel (2001), among others (i.e. Hesari *et al.*, 2013), have suggested by performing a movement over six times, significant learning will take place.

Despite support for its intra-rater reliability through the use of statistically diagnostic tests, in subsequent to research, the consensus for the SEBT inter-rater reliability is limited (Gribble *et al.*, 2013). Gribble *et al.* (2013) completed a study to determine the inter-rater reliability of the SEBT. Gribble *et al.* (2013) built a strong argument for inter-rater reliability as 29 healthy participants were tested, with each participant producing 16 variables of normalised and non-normalised reaching distances. The investigation was employed at two different testing sites, with Gribble *et al.*'s (2013) findings producing a strong correlation and that the inter-rater reliability could not be faulted with all 16 measures.

Munro and Herrington (2010) identified that the SEBT is a time consuming protocol, a major limitation when trying to find consistent results. One completed procedure involves the participants standing on one leg and reaching with the other in a number of different positions. Participants may then have to complete this method from practice trials to testing measured trials (Munro and Herrington, 2010). While this may be the case, there is good research suggesting the SEBT has been used within medical practice, testing not only injuries in the lower limb and injury prediction but used also for specific ankle instability (Munro and Herrington, 2010). Using this corre

2.6 Rational of Study

Naicker *et al.* (2007) states that lateral ligaments sprains of the ankle are sustained in the inverted and plantar-flexed movement. He suggests that when the ankle is in this position, the evertor and dorsiflexor muscles are lengthened and act eccentrically (Naicker *et al.*, 2007). Weak dorsiflexors that cannot act with sufficient eccentric strength will therefore allow for excessive plantar-flexion and inversion, placing additional stress on the lateral ligaments of the ankle joint and predisposing the players to injury (Naicker *et al.*, 2007). It could then be suggested that a study determining the effects of tape on the joint would be the next progressive step in research to understand the effectiveness of the tapes in relation to balance and stability, supporting the joint. Studies such as; Passerallo and Calabrese (1994), Murtaugh (2001), and Naicker *et al.*'s (2007) have confirmed that lateral ligament injuries are most common within sport. From qualitative research, Passerallo and Calabrese (1994) established that ankle taping, throughout history, has been the most common technique applied to support, and further prevent such injuries. However, while the study reinforces the use of taping the ankle joint to further prevent re-injury in the return to competition phase with an athlete, Passerallo and Calabrese (1994) found the consensus to the effectiveness of ankle taping to be limited. As a result, there is conflicting research between what different tapes, and so, a future research avenue would be to compare the tapes and a common theme; balance, therefore, the basis of this current study. Consequently, this study will adopt a purposeful sample, to collect participants due to desired characteristics within the population through random selection; sporting background, sane gender and the team easily accessible to partake in the study (Clark-Carter, 20009). With the findings from the purposed study and supporting the hypothesis, it will be determined whether different tapes affect a subject's balance in different ways.

CHAPTER THREE: METHOD

3.1 Participants

The current study assessed a total of 16 female hockey players gathered from a sporting University. The sample group were all female with a mean age of 20 (± 1.4). The hockey players were all sub-elite level having played hockey from club to district level, with a minimum of 2 years of competitive hockey experience before representing the University. This was introduced to cut out variables between elite and sub-elite hockey players. All subjects attended two team training sessions and played two matches a week. All participants willingly signed consent forms and read information sheets, to understand their rights within the study, freedom to withdraw at any time and also showing compliance to participate in the study. All participation was voluntary whilst under the supervision of the researcher. To be included in this study, all participants had to be free from a lower extremity injury and were excluded if they had obtained a serious injury involving the hips, knees and ankles from within the last 12 months. Injured subjects were exempt to avoid an effect on results and reaching distances and to provide safety to the subjects, hence avoiding re-injury. If any pain was experienced during the test, participants were advised to stop, not participating further.

3.2 Research Design

Testing took place in the National Indoor Athletics Centre (NIAC) based in Cardiff Metropolitan University. All testing was supervised and measured by the same researcher to make certain all testing procedures were performed to the correct standard so to avoid any anomalies within results and to ensure the participants' safety. The environment provided was a large spacious environment, with the area cleared of all obstructions, with little noise and distractions to ensure full concentration and for the test to run smoothly without disruptions.

Prior to the testing, the participants were given both a verbal and visual demonstration by the researcher. All participants were given the same information in the same manner prior to the beginning of the test. Each subject performed three practice trials on their dominant leg to become familiar with the task and understand the correct procedure. For each variable, each participant completed the testing within six trials including practice trials, with a 24 hour period between each variable testing in order to limit the familiarisation of the test, and to reduce the results getting better through practice. During the test, the participants were asked to complete the test wearing shorts and no shoes.

All subjects were tested on balance using the Star Excursion Balance Test (SEBT). The SEBT consists of eight increments pointing in eight different directions in the shape of a star. Four directions follow the cardinal directions; anterior (A), posterior (P), medial (M) and lateral (L) with respect to the stance leg. Accordingly, 45 degrees between each of these directions are another four directions; anteromedial (AM), posteromedial (PM), posterolateral (PL) and anterolateral (AL). The test required the participants to sustain a base of support through one leg and control a range of movements through different directions and distances with the other, without compromising the support leg (Gribble and Hertel, 2003). The SEBT was performed by the subject, with their stance leg being the dominant leg and the trailing leg becoming the reach leg. The dominant leg for each participant was determined through three minor trials; recovery from a posterior push, replicating kicking a ball, and assimilation of a step up (Hoffman *et al.*, 1998). Each subject performed the trials using their reach leg to reach as far as possible in each of the eight directions of the star, and using their most distal end of their foot to gently touch the increments taped to the floor, while maintain their balance on their stance leg. To maintain control through all participants, they were asked to keep their hands on their hips throughout the whole procedure. The directions of the star were at 45° increments taped to the floor with white zinc oxide tape, moving outwards from the centre point of the grid and measured using a Goniometer. Two test subjects were used as a pilot test for the researcher to make amendments to any time-taking task or any problems that occurred, so that future participants could understand and complete the testing procedure without any errors. Being that no amendments were made, the participants used for pilot testing were also used for data collection, with their results being anonymously added in.

For a completed movement, the subject maintained a single-leg stance on the dominant leg and reached out to the furthest possible point with their reach leg along the appropriate vector. Subjects were asked to repeat the attempt if it was classed as a miss-trial. Miss-trials were discarded and the subject repeated the test if the participant failed to return to the start and end position, lost balance or control of themselves any point during the test, lifted the stance foot away from the centre of the star and if the subject failed to touch the line while maintaining weight bearing and balance on the stance leg. The subjects reached out as far as possible and gently touched the furthest point with the most distal point of their reach leg. This was done in order for stability and proprioception to be observed through adequate neuromuscular control of the stance leg. Between each reach of the eight directions, participants returned to a bilateral stance before reaching for the next segment. Each reach was noted by the researcher placing tape on the reach point, and then the distance was measured from the centre of the star to the reach point. All measurements were recorded by the researcher using a tape measure.

All subjects were required to attend three sessions and performed the test with every taping variable in order to gain a completed set of data. For each different variable, three reaches were recorded in each direction to improve the reliability of the study. Between each round of reaches the researcher collected the data leaving the subject a 10 second window for rest period. For each direction with each participant, the best score of all three reaches was used for data analysis.

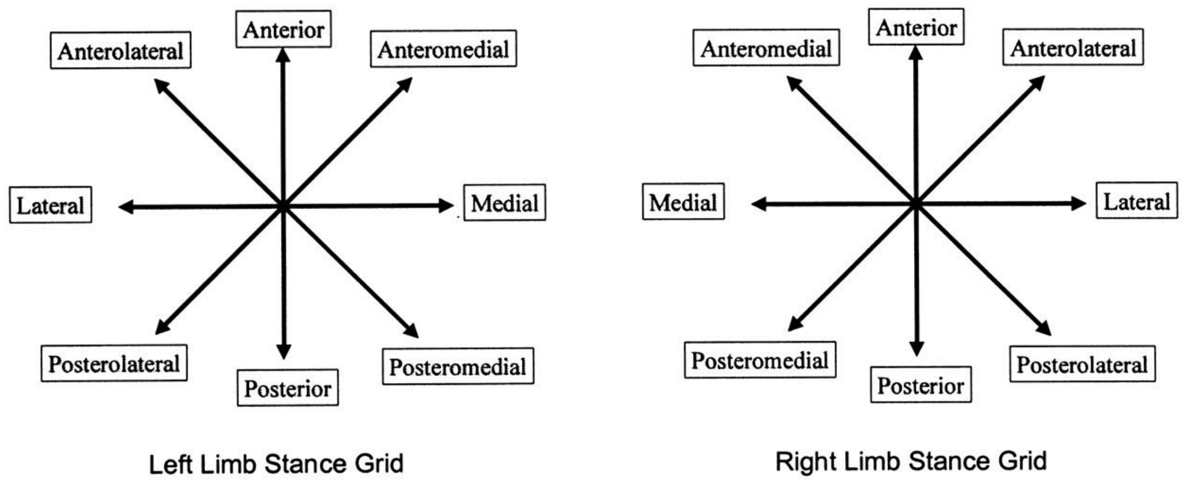

Figure 1: Testing Grid for the Star Excursion Balance Test. (Hertel *et al.,* 2006).

3.3 Procedure

Prior to beginning of test, subject completed a skin test to test for allergies when using the tapes. All subjects had no reactions. Subjects completed a warm up on a static bicycle for five minutes and then personal foam rolling and dynamic stretching of the lower limb to stretch the muscles used during the test. Participants wore shorts, with no shoes or socks. Day one: Warm up completed. Participants completed three practice trials of the SEBT, before complete three recorded measures of the SEBT. Day two: Warm up completed. Participants taped with conventional rigid tape. Participants completed three practice trails, and then completed three recorded measures of the SEBT. Day three: Warm up completed. Participants taped with kinesiology tape, completed three trial tests, and then completed three recorded measures of the SEBT.

3.4 Method of Application

Two different applications of tapes were used for the study. The rigid tape; white zinc oxide; followed a traditional basketweave method where each strip of tape is applied interwoven with another producing a 'stirrup' and 'horseshoe' shapes covering both medial and lateral malleoli, the plantar surface and the posterior surface of the hindfoot. The kinesiology tape used three strips. The first; a spiral stripe, anchored over the lateral malleolus and lateral ligaments with maximum tension on the tape, spiral up the leg to tibia. The second strip; a U stirrup, maximum tension, covering both malleoli and the third strip; a U stripe, applied with maximum tension from the Achilles tendon over both malleoli.

3.5 Statistical Analysis

Through statistical analysis and analytical text, a greater depth of understanding could be derived from the resultant data found. Therefore all data and findings will be reported through a statistical means and all accumulated together on excel and SPSS statistical software to produce facts and derive sound knowledge and information and to reinforce the study.

All data was accumulated and saved onto a Microsoft Excel spreadsheet, with subjects given a different identity through numerical values (1-16) to protect and exclude individualism. All scores were kept, with the participants' best reaches combined together to produce an overall mean best reach for each direction. The scores were then moved into a statistical software programme (SPSS) in order to analyse the data further. A one-way repeated measure analysis of variance (ANOVA) was used to compare variables; no tape, conventional rigid tape and kinesiology tape within each reaching distance, with a significant value set at <0.05. A Mauchly's test of sphericity was used to assume sphericity $P>0.05$. When sphericity was violated and not assumed ($p<0.05$), Greenhouse-Geisser adjustments were made. This, known as a test within-subject effects, is done to establish whether a significant difference was achieved between the testing trials. The results between the variables for test direction were accepted as statistically significant when the 'p' value (probability) was shown to be less than 0.05 ($p<0.05$). Furthering this, if a significant difference was seen, a Bonferroni post-hoc test was run to determine where the difference lies.

CHAPTER FOUR: RESULTS

4.1 Introduction

The purpose of the study was to understand the difference between the effects of different taping variables on an athlete's balance whilst performing the Star Excursion Balance Test (SEBT). The following chapter shows the process of data analysis that was developed from data collection to performing statistical analysis on SPSS. All data was grouped together and analysed using a one-way repeated measure analysis of variance test (AVONA). This was done to determine if a significant difference between the taping variable occurred in relation to reaching distances.

4.2 Hypothesis

A substantial difference should be seen in respect to the distance achieved on the SEBT when using kinesiology tape compared to conventional rigid tape.

4.3 Subjects

Sixteen subjects gave consent to participate throughout the course of the study and complied with all testing procedures. The subject's mean descriptive statistics are demonstrated below.

Table 1: Mean values of descriptive statistics for the participants including age, height and weight. (N=16)

	Age (yr)	Height (cm)	Weight (kg)
Mean	20	165.6	65.1
Standard Deviation	1.4	4.9	7.9

4.4 Star Excursion Balance Test

Figure 1 illustrates the mean reach scores for each direction compared against the taping variables. By looking at the graph, a small difference can be seen between each taping variables, however an analysis of variance was needed to determine whether or not the difference seen was significant.

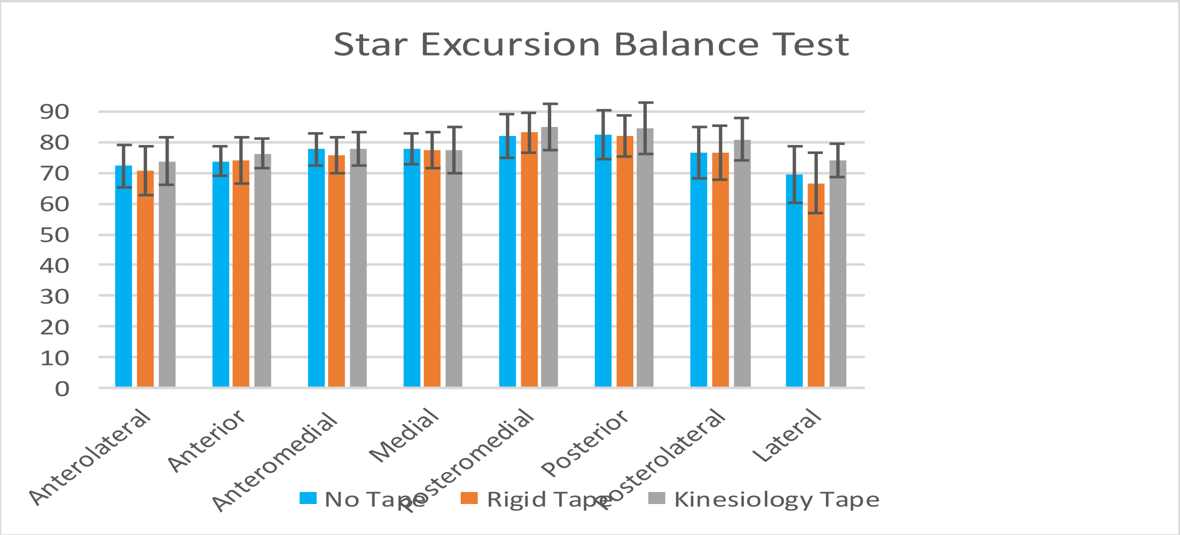

Figure 2: Star Balance Excursion results demonstrated in a graph form for all eight directions and the three taping variables.

4.5 Anterior

For the anterior direction, the participants completed three trials for each taping variable. Their best scores were used and collectively grouped together to produce a mean for each variable. Illustrated in the table below are the mean scores for each taping variable for the anterior direction.

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	73.88 ±4.86	74.06 ±7.43	76.25 ±4.82

Table 2: Mean and standard deviation of the anterior direction for no tape, rigid tape and kinesiology tape are demonstrated below. (N=16)

4.5.1 One-Way Repeated Measure ANOVA

A repeated measures ANOVA was used to identify any significant differences between the taping variables for the anterior direction. Mauchly's test of sphericity revealed that the sphericity could not be assumed; p = 0.015, as a significance for p was set at p<0.05. Greenhouse-Geisser was used for adjustment with sphericity, giving a significant value of p = 0.234 (f = 1.525), which is greater than the significant value of p < 0.05. Thus, no significant difference was seen for each taping variable within the anterior direction.

4.6 Anteromedial

For the anteromedial direction, participants completed three trials with each taping method. Below, for the anteromedial direction, are the best mean reach scores of all three trials. (N=16)

Table 3: Illustrated are the mean reach scores for the anteromedial direction.

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	77.69 ±5.44	75.69 ±5.83	77.88 ±5.48

4.6.1 One-Way Repeated Measure ANOVA

To identify any significant differences between the mean results of each taping method for the anteromedial direction a repeated measures ANOVA was used. The significant value was set at p=0.05. Using Mauchly's test, a result of p = 0.278 revealed that sphericity could be assumed. Assuming sphericity, a value of p = 0.164

(f = 1.918) exposed no significant difference between the taping variables in the anterolateral direction.

4.7 Medial

The medial direction was in respect to the stance leg, with the movement leg reaching directly out to the medial side three times for each taping method. The results of the mean distance reached are below with the standard deviation for no tape, rigid tape and kinesiology tape.

Table 4: Medial results including mean and standard deviation for kinesiology tape, rigid tape and no tape are revealed below. (N=16)

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	77.94 ±5.03	77.31 ±5.90	77.63 ±7.55

4.7.1 One-Way Repeated Measure ANOVA

Medially produced results for the mean reaches however, a repeated measures ANOVA, significance set at $p<0.05$, was needed to understand the results to determine any significant differences between no tape, rigid tape and kinesiology tape. Result of the sphericity test by Mauchly was $p = 0.455$, enabling sphericity to be assumed at $p = 0.856$ ($f = 0.156$). As a result of this, no significant difference was seen.

4.8 Posteromedial

All participants completed three trials for each testing measure, with a mean best reach and standard deviation calculated. They are demonstrated in the table below.

Table 5: The mean and standard deviation results for the posteromedial direction are illustrated in the table below. (N=16)

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	82.13 ±6.96	83.19 ±6.65	84.94 ±7.49

4.8.1 One-Way Repeated Measure ANOVA

With a significant value set at $p<0.05$, a repeated measures ANOVA was calculated to discover if any significant differences occurred between the taping variables in the posteromedial direction. A Mauchly's test of sphericity was completed, $p = 0.739$, revealing sphericity could be assumed. A review of this, lead to an insignificant value, $p = 0.089$ ($f = 2.620$), presenting no significant difference between the tapes in the posteromedial direction.

4.9 Posterior

The posterior direction required the participant to reach directly behind themselves. Three trials were completed with the SEBT in this direction for no tape, rigid tape and kinesiology tape respectively. From the three trails, the best score was kept, and added together to produce a mean score, explained in the table below.

Table 6: Table to demonstrate all the mean scores and standard deviation results for no tape, rigid tape and kinesiology tape in the posterior direction. (N=16)

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	82.44 ±7.86	82.13 ±6.60	84.63 ±8.24

4.9.1 One-Way Repeated Measure ANOVA

A one-way repeated measures ANOVA was completed with a significant value set at $p<0.05$. For the posterior direction, a sphericity test revealed sphericity could be assumed as p = 0.930. Assuming sphericity exposed p as 0.104 (f = 2.443), resulting in no significant difference seen for each taping variable in this direction.

4.10 Posterolateral

Using the different taping variables; no tape, rigid tape and kinesiology tape; each participant finished three trials with each variable. Their best score for each variable was used to create a mean value. This is shown below, along with the standard deviation.

Table 7: A table to demonstrate the mean and standard deviation results of the SEBT for each taping variable. (N=16)

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	76.81 ±8.40	76.81 ±8.82	80.94 ±6.85

4.10.1 One-Way Repeated Measure ANOVA

A repeated measures ANOVA was used to identify any significant differences between the taping variables for the posterolateral direction. Mauchly's test of sphericity revealed that the sphericity could not be assumed; p = 0.023. As a significant value, Greenhouse-Geisser was used for adjustment with sphericity, giving a value of p = 0.017 (f= 5.738). This figure being below 0.05 suggests a significant difference has been identified between the taping variables. A Bonferroni post-hoc test is used to compare individual variables against one another to determine where the difference lies. The results of this test suggest that there is no significant difference between using no tape and conventional rigid tape (p = 1.000) nor between conventional rigid tape and kinesiology tape (p = 0.085). However, while this may be the case, there was a significant difference seen between no tape and kinesiology tape (p = 0.047), in reach distances in the posterolateral direction.

4.11 Lateral

The lateral direction working from the stance foot meant the participants had to cross legs to achieve a reaching distance. They completed this three separate times for each variable however, only their best score was used to create a mean and standard deviation illustrated in the table.

Table 8: Mean best reaching distances achieved with the standard deviation for each taping variable. (N=16)

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	69.56 ±9.15	66.75 ±9.96	74.06 ±5.47

4.11.1 One-Way Repeated Measure ANOVA

To understand whether a difference was seen in the lateral direction, a one-way repeated measures AVONA was carried out. Firstly, Mauchly's test revealed that sphericity could not be assumed; p = 0.011. Adjustment for spericity lead to a Greenhouse-Geisser test, giving a value p = 0.006 (f = 7.978). Thus, suggesting a significant difference between the testing variables due to p <0.05. To understand the contrast between the variables, a Bonferroni post-hoc test was performed. From this test, three different results were achieved; no significant difference between no tape and conventional tape (p = 0.080); nor no tape and kinesiology tape (p = 0.091). However, a significant difference was seen between the taping methods; rigid tape and kinesiology tape (p = 0.020), hereby suggesting that the researching distance differed within the lateral direction between the type of tapes.

4.12 Anterolateral

For each participant, their best score was used collectively to create a mean score for the anterolateral distance, illustrated in the table below.

Table 9: Table to demonstrate the mean value for the anterolateral distance. (N=16)

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Mean	72.25 ±4.86	70.75 ±7.82	73.88 ±7.69

4.12.1 One-Way Repeated Measure ANOVA

A one-way repeated measures ANOVA was used to identify any significant differences between the taping variables for the anterolateral direction. Significant value was set at $p<0.05$. Mauchly's test of sphericity revealed that the sphericity could be assumed; p = 0.278 (f = 1.918). Sphericity assumed gave a significant value of P = 0.164. As a result of this, no significant difference was seen for each taping variable in the anterolateral direction.

4.13 Summary

From looking at these results (figure 1), it is evident to see that a difference occurred between the taping variables; with an improvement in the mean reach scores for the kinesiology tape in all but one direction. Preliminary tests provided assumptions for the main analysis. The ANOVA presented a significance in two of the groups; lateral and posterolateral ($p<0.05$). Furthermore, the Bonferroni post-hoc test revealed that the significant difference occurred ($p<0.05$) between; no tape and kinesiology tape (p = 0.047) within the posterolateral direction and rigid tape and kinesiology tape (p =

0.020) in the lateral direction. However, these improvements in reaching results could be attributed to the kinesiology tape suggesting kinesiology tape may have had a positive effect on balance in the two directions. Despite these result, caution must be taken when interpreting the results due to a loss of statistical power. This loss of statistical power could be linked to the sample size; including 16 participants who were generalised to female non-elite hockey players. Significantly, the sample size was small compared to the general population; therefore, a larger variance effect could have arisen. Controversially, it could be suggested that with a larger sample size a trend could be seen, creating a more consistent development through the results.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

The purpose of the study was to determine the effects of different sports tapes; kinesiology tape and conventional rigid tape, using the Star Excursion Balance Test (SEBT). Sixteen female hockey players from Cardiff Metropolitan University participated within the study; with holistic control kept throughout as all 16 participants completed the testing with all taping protocols (Clark-Carter, 2009). The SEBT was chosen to test whether balance was affected by taping the lateral ligaments of the ankle with both kinesiology and rigid tape. The main findings from the results showed that there was a significant difference in two directions of the SEBT; posterolateral and lateral, when comparing the distances achieved. While this may be the case, many factors could have contributed to the results gathers and their outcomes, and are identified and discussed in the following section.

5.2 Explanation of Findings

All participants completed the testing protocol of the SEBT three times for each different taping variable; no tape, rigid tape and kinesiology tape. Participants reported no discomfort from either taping variable and no unfavourable events occurred during the trials; for example, no adverse reactions to the tape. From the three results the best distance scored for each distance was used, and then an average was created by collectively adding together all 16 results. This was done to look at the effect of the taping variable on performance and distance reached. The reaching distances evidently improved, with the exception of one distance, producing a greater mean reach achieved using kinesiology tape than both conventional rigid tape and no tape. Results of this study coincide with Murray's (2000) research; identifying that kinesiology tape can in-effect significantly enhance joint active range of motion. Thus, if the range of motion at the joint can increase, it could be suggested that a further reach was possible. While a comparison to Murray's (2000) research was promising with good correlation to the findings within the current study, presenting kinesiology tape increase joint movement, caution must be taken as Murray's study included only two participants' therefore lacking statistical significance and reliability. With the exception of two directions, the conventional rigid tape was of a lower mean than that of the control measure; no tape. A one-way repeated measure ANOVA was used to determine the significance of these descriptive results. The ANOVA identified a significant difference (<0.05) on the star excursion balance test with two different directions; lateral and posterolateral. After an analysis of the results, it could be seen that there was a significant difference in the posterolateral direction of p = 0.047 between no tape and kinesiology tape. Thus, in the posterolateral direction, a better reach score was achieved using the kinesiology tape on the SEBT than no tape. It was also seen that in the lateral direction there was a significant difference p = 0.020 between conventional rigid tape and kinesiology tape therefore, from this result, it can be distinguished that a further reach score was achieved using the kinesiology tape over the conventional rigid tape.

The taping technique using conventional rigid tape was a traditional interwoven application of strips of 'stirrups' which travelled medially to laterally, covering both malleoli and the plantar surface of the foot and leg. This followed by 'horseshoe' strips which travelled from the medial aspect of the leg to the lateral surface and placed perpendicularly on the hind foot (Passerallo and Calabrese, 1994; Lohrer, Alt and Gollhofer, 1999; Wilkerson, 2002). Thus, the stirrups produced a force vector covering the lateral ligaments of the ankle, producing a restraint against inversion and plantarflexion of the hindfoot (Wilkerson, 2002). This method of taping used, provided support to the ankle and limited the range of movement, (Lohrer, Alt and Gollhofer, 1999; Klawon, 2002) due to the tapes' inelasticity and stiffness (Wilkerson, 2002; Hopper *et al.*, 2009). Hence, it could be suggested this is a reason as to why the reach scores with the rigid tape were significantly shorter in the posterolateral and lateral directions, as the rigid tape was aimed to support the lateral ligaments. It can also be proposed that, if the ankle is enclosed with rigid tape supporting these ligaments, while a reduced reach was obtained, that the subject is more stable and in effect, balanced. Cortesi, Cattaneo and Jonsdottir (2011) proposed that an indication of instability and balance is attributed to the amount of movement at the centre of pressure. Incorporating this theory into practice, the ankle is the point of pressure, with the distances reached the movement at the centre point. If the proposed theory by Cortesi *et al.* (2011) is correct, then it could be suggested that the rigid tape which enclosed the ankle, resulted in a decreased distance; therefore, less movement at the ankle joint, indicating better stability within subjects, hence resulting in a more balanced body.

5.3 Star Excursion Balance Test

To determine the effect of different sporting tapes on balance the star excursion balance test was utilised with 16 healthy subjects. Munro and Herrington (2010) utilised the SEBT to test for injury prediction and specific ankle instability, hence, leading to a positive enforcement of the use of this test within the current study, Although this test is used in research studies, Lohrer, Alt and Gollhofer (1999) have determined that range of movement tests, such as the star excursion balance test, employ open kinetic chain actions and are of limited functional significance. As discussed, propriception is a vital component of balance and hence, being stable. Joint position sense, formally known as proprioception is best tested through closed chain exercises, rather than its counterpart, open kinetic chain elements (Lephart and Henry, 1996). It is also apparent from a sport perspective, open kinetic chain patterns are less frequent, specifically targeting one muscle (Findley and Brown, 1999). Somewhat different to its equivalent; closed kinetic chain, which conditions muscle groups hence, a stronger correlation to sport is reciprocated (Findley and Brown, 1999). Thus, to fully understand the effect of sports taping on balance within the sporting environment and its lasting effects on joint position sense, a transition from clinical setting to sport specific testing should be outlined. Other research studies could also include more modern technologies to limit human error from measurements; for example, force-plate technologies, to measure dynamic postural balance and stability.

5.4 Strengths

There is controversial evidence in literature to support the Star Excursion Balance Test. Kinzey and Armstrong (1998) completed a study to determine the reliability of the test, with the results being inconclusive for dynamic balance. This being the case, Kinzey and Armstrong (1998) also proposed that practice improved results of the test and consequently, the reliability of the test could be questioned. In contrast, Earl and Hertel (2001) suggested that the testing for each variable should be completed within six trials including practice trials to limit the familiarisation of the test. However, they advised to reduce results improving through practice and to obtain an accurate ‘original’ reading, less trails should be completed (Early and Hertel, 2001). More recent research by Munro and Herrington (2010) confirm that SEBT is a reliable measure for lower limb function with healthy recreational non-elite athletes, which suggests that due to the participants within this study, the test is an appropriate and reliable measure. It was also found from their study that results stabilised after 4 trails therefore, supported three practice trails then collecting measurements within the current study (Munro and Herrington, 2010).

It is evident that the method of application with the taping variable was highly recommended for use within this study. As in previous literature, it was apparent that the utilisation of rigid tape, creating ‘stirrups’ to produce force vectors acting on the ankle ligaments (Lohrer, Alt and Gollhofer, 1999; Wilkerson, 2002), and then locking in and supporting the vectors with more strapping (Passerallo and Calabrese, 1994; Lohrer, Alt and Gollhofer, 1999; Wilkerson, 2002), was successful in testing (Passerallo and Calabrese, 1994). Thus, could enable positive reinforcement for future studies adopting this strategy and further, researchers incorporate it into practice.

As a result of a number of different procedures, the reliability of the testing increased. All taping and testing was done by the same researcher. Furthermore, as suggested by Clark-Carter (2009), using the same subjects and altering one variable; the tape, kept control and increased validity of the testing, while minimising factors which could have affected it. As a result of this, changes were identified between each taping variable with relationships observed between different factors; distances. By creating the same environment for each participant, the reliability could have been increased further. Prior to the beginning of the study, to maintain consistency throughout research, Naicker *et al.*’s (2007) protocol was adopted. Thus, a subject unable to perform, pain or tenderness for a period of five days or longer, as a result of damage to muscle, ligament or bone was regarded as an injury, and therefore could not participate (Naicker *et al.*, 2007). The participants were also asked to complete the testing with shorts and no shoes, thus to enable a fluid movement and not limit any joint or limb (Vormittag, Calonje and Briner, 2009). This was done to increase reliability and consistency throughout the test as the participants' balance or movement would not be disrupted.

Many researchers have suggested, from their own personal experience, that further research is needed to develop the understanding of taping methods and their effect on body limbs and their function.

5.5 Weaknesses and Further Development

It is known throughout the sporting and medical industry, athletes and sporting personnel alike continually tape both muscles and joints to control movement and support the area in case of re-injury (Kneeshaw, 2002; Morris *et al.*, 2013). During this study all healthy subjects participated, having no history of lower limb injury in the past 12 months, thus enabling suggestions of illogical results and a futile study as the tape was not used for its original purpose; supporting and controlling movement to prevent re-injury (Kneeshaw, 2002; Bradyopadhyay and Mahapatra, 2012; Morris *et al.*, 2013). This could become a concern within literature, as taping is widely known for its use within the injured population to help support the joint and provide protection during activities (Williams *et al.*, 2012). However, while this may be the case, Lohrer, Alt and Gollhofer (1999) along with many other theorists (Cámara *et al.*, 2011; Hesari *et al.*, 2013) utilised healthy participants within their research, with no history of injury during the first 6 months or longer prior to the start of the research. While this may be the case; it is evident from Callaghan *et al.*'s (2002) research that an enhancement with proprioception capabilities was achieved from tape within subjects with poor proprioception post application only. This method of testing healthy subjects could be used to create a base line data; where by theorists can work from to aid injured athletes in the rehabilitation programme. From this, a prospective area for further development could be to develop base line data for injured and uninjured athletes; comparing the effects of different sports tapes, enabling an original source of information to help rehabilitations and athletes alike.

The purposive sampling method utilised within the current study (Guarte and Barrios, 2006 Clark-Carter, 2009), when reviewed from a reliability perspective, could potentially be viewed as a negative and possibly a limitation. For example, the study tested 16 individuals for each taping variable, which is seen, in terms of research, a small sample size. This sample size was specific to non-elite university level female hockey players, which could not be generalised to all female hockey players. Additionally, could not be related to the general population (Berg and Latin, 2008) hence, a cross-sectional meta-analysis could not be made with genders, elite vs. non-elite, different sports, different ages, and many other different characteristics. However, the purposive sampling was chosen because an in-depth measurement could be collected from a specific population. Controversially, it was utilised during this study, as most studies are inclined to focus upon elite athletes and less studies are generalised on the lower field hockey community (Murtaugh, 2001).

As discussed, the sample size of the study was specifically focused on a purposive sample, resulting in limited subjects (N = 16). Argued that a purposive sample can facilitate research within specific inclusion criteria, for example Cortesi, Cattaneo and Jonsdottir (2011) controversially, it could be seen through research, as a limitation due to the number of participants. More specifically, to create a more reliable study and increase internal validity, a focus on a broader or greater sample size could be facilitated, thus, achieving statistical significance; a smaller variance within the resulting data and decrease sample error; could possibly be produced (Callaghan *et al.*, 2002; Berg and Latin, 2008).

The testing method that was used during the study followed the same method for each participant; day one; no tape, day two; rigid tape, day three; kinesiology tape. Although a period of 24 hours was given between each testing day to limit familiarisation (Earl and Hertel, 2001), and on each day the SEBT was completed no more than six times (Earl and Hertel, 2001), an element of learning or recognition could have occurred. Along with these measures to help reduce the learning effect, the order of the conditions, for example the tape, could have been randomised for each participant (Sawkins *et al.*, 2007; Cámara *et al.*, 2011). Similarly, the SEBT was performed clockwise, with each repetition the same, anterior, anteriormedial, medial, and so forth, creating repetition and possibly muscle memory with the subjects. The order of the test itself could then be randomised to produce variability and to try limit learning effect. Future research could include a randomised order (Hesari, 2013) of the taping variables and the test itself to firstly, limit learning effect and secondly, limit potential fatigue.

During this study, the dominant leg was established through three trials; assimilating a step up, replicating kicking a ball, and a posterior push (Hoffman *et al.*, 1998). From these tests, the dominant leg was discovered yet an interpretation of what leg was dominant could be misleading. The participants' dominant leg that was used and therefore taped, was the movement leg. For example, whatever leg the participant led with or kicked with became the stance leg and so, the taped leg. A discussion could be made that during the SEBT; the dominant stance leg should have been used and taped rather than the dominant movement leg. This could have been a reason as to why in many other studies researchers have completed the SEBT bilaterally with both limbs and should continually be used throughout future research.

Despite the fact that a significant difference was seen in two directions of the SEBT; laterally with rigid tape and kinesiology tape (P=0.091), and posterolaterally with kinesiology tape and no tape (p=0.047), leg length was not normalised within this study. Leg length could not be normalised due to limited time available to develop the testing procedure; however, it could be suggested that leg length was an influencing factor on distance reached. It is suggested that leg length could possibly influence distances reached as the longer the limb, a further distance could be reached, compared to a shorted limb, a shorter distance could be reached. Both Gribble and Hertel (2003) and Hesari *et al.* (2013) found strong correlations within their studies' between leg length and excursion distance reached, supporting the idea that leg length is a viable factor that needs to be considered. Furthermore, the inter-rater reliability of the SEBT increased dramatically when leg length was normalised (Gribble *et al.*, 2013) upheld the idea that this factor needs to be considered in further research.

It is established from Slupik *et al.* (2007) that the affect KT had on performance and muscle's motor units differed with respect to time; noticeably increasing due to a prolonged use of the tape. Results observed that 72 hours post application, muscle bioelectricity increase; however, 24 hours post application of KT, the same rise was seen though subjects maintained a higher torque for a longer duration (Slupik *et al.*, 2007). From this, it could be suggested, that for future developments with KT, studies could be introduced, applying tape 24 hours pre testing, to try and achieve full activation and effects of the tape.

5.6 Conclusion of Discussion

To conclude, there is limited research developed to understand the full effects of different sports tapes on balance performance. Further research is needed in this field, to provide a detailed account on whether different sports tapes do in fact aid an athlete in respect to balance and stability. The results of this study suggested that kinesiology tape did produce a further reach than no tape, hence improving the resultant distances on SEBT whereas, rigid tape prevented a further reach, resulting in a shorter distances than no tape. Having considered the limitations from the study, the use of SEBT provided reliable results, hence an accurate conclusion could be made.

CHAPTER SIX: CONCLUSION

6.1 Conclusion

The purpose of the study was to identify if either kinesiology tape or conventional rigid tape had an effect on the Star Excursion Balance Test within female University hockey players. The outcome of the study could provide sports therapists and athletes alike, to correctly understand the properties and correct use of sporting tapes, enabling integration of use from training, and competition to rehabilitation settings.

Hockey is a well-accepted sport played through all generations across the globe (Murtaugh, 2001; Naicker *et al.*, 2007). This high-intensity game involves large distances covered using interchangeable speeds and stop-start movements (Murtaugh, 2001; Naicker *et al.*, 2007). As performers progress, increasing their capability within the sport, a correlation is produced with an increased risk of injury (Naicker *et al.*, 2007). As previously identified, lower limb injuries account for most injuries within hockey with 60% of these injuries reported as lateral ligament ankle sprains (Murtaugh, 2001; Naicker *et al.*, 2007; Hopper *et al.*, 2009). All ankle sprains are different, with the severity of each depending on the mechanism of injury, and so, the time away from the sport varies, from two through to exceeding eight weeks (Naicker *et al.*, 2007). Furthering this, Naicker *et al.* (2007) tested proprioception abilities and balance, established that proprioception a predisposing factor to lateral ligament ankle sprains, and hence, re-injury and lack of balance. By identifying where weaknesses lie within performers, rehabilitative and preventative strategies can be produced. The evidence found gave significant support to test the effects of different sports tapes (preventative strategy) on the lateral ligaments of the ankle.

The main findings of the present study illustrate dynamic ankle balance had a significant impact on two of the multidirectional reaches of the SEBT with respect to the taping variables. Significant differences are witnessed with; the posterolateral ($p = 0.047$) direction between no tape and kinesiology tape, and the lateral ($p = 0.020$) direction of rigid tape and kinesiology tape. Within reason, the results do support the hypothesis, as it was suggested a difference would be seen, which has been observed from the results, however the difference was only significant in two directions of the star. While there are significant results shown from this study, a variety of factors could have affected the results; for example, sample size. The sample size of the study (N = 16) is small compared to previous research incorporating larger sample size; Callaghan *et al.* (2002) where N = 52 and Murtaugh (2001) who tested 158 participants in order to gain statistical significance within the results. From this, it could be suggested that a large sample size could be utilised, to gain statistical significance and hence, increase the reliability.

It is believed that the distances decreased when using conventional rigid tape is due to the method of taping. It is known that the primary mechanisms of lateral ligament angle sprains are from excessive inversion and plantarflexion movements (Hertel, 2002). These movements excessively stretch the lateral ligaments of the ankle, hence when the tape was applied, the ‘stirrups’ travelled medially to laterally, creating a force vector upon the ankle, and limiting these dangerous movements. The horseshoe strips placed perpendicularly helped enclose the ankle, with the strong adhesive created a bond to the skin, helped to limit movements, therefore producing a more stable body. Similarly, kinesiology tape, an elastic tape, when applied created a pulling sensation on the skin, thus, enabling full range of movement but increasing nerve stimulation below the skin, aiding in proprioception. It is supposed that these effects from KT are a reason as to why a further distance was achieved.

In summary, the study provides an understanding of different sports tapes and their properties, and their development into practical sessions. It is seen that a difference has occurred in the distances reached; however, further studies should utilise the limitations from within this present study, to increase the statistical power of the results.

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APPENDICES

APPENDIX A

Cardiff Metropolitan University
PARTICIPANT CONSENT FORM

Title of Project: The effects of Kinesiology Tape and Conventional Rigid Tape on Star Excursion Balance Test Performance

Name of Researcher: Nia Morgans

Participant to complete this section: Please initial each box.

1. I confirm that I have read and understand the information sheet for this evaluation study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that it is possible to stop taking part at any time, without giving a reason. ☐
3. I also understand that if this happens, your relationships with Cardiff Metropolitan University will not be affected. ☐
4. I understand that information from the study may be used for reporting purposes, names will not be identified. ☐

____

Name of Participant

______________________________ ______________

Signature of Participant Date

______________________________ ______________

Name of person taking consent Date

____

Signature of person taking consent

APPENDIX B

Cardiff Metropolitan University
PARTICIPANT INFORMATION SHEET

Project Title

The Effects of Kinesiology Tape and Conventional Rigid Tape on Star Excursion Balance Test Performance

Background

The aim of the study is to see if conventional rigid tape or kinesiology tape has an effect on balance during the star excursion balance test.

How

Participants will complete informed consent forms then participate in the study. The study will involve completing a test procedure on three separate days; star excursion balance test. The participants will be involved in three variables; a control with no tape, a taped ankle using rigid tape and a taped ankle using Kinesiology tape. Participants will be asked to wear shorts to limit restriction of lower limb movement and no socks will be worn.

Risks

Participants will be asked first to do a skin test, to ensure no allergic reaction occurs as a result of the adhesive on the tapes. A completion of a warm up prior to testing will limit the risk of injury. All participants will be informed of health and safety, and if they are feeling unwell, injured or do not want to take part, they can withdraw at any time.

Your Rights

Participation within the study is voluntary, meaning you are free to withdraw from participating at any time, with no reason necessary.

Confidentiality

Participants privacy will be respected with all participants' information, names and contact details will be kept anonymous. Careful steps will be taken to ensure you cannot be identified from results, or pictures if any.

Contact

If you require any additional information, or any other queries, feel free to contact me further.

Nia Morgans
Undergraduate BSc Hons, Sports Conditioning, Rehabilitation and Massage
ST20008197@outlook.cardiffmet.ac.uk

APPENDIX C

One-Way Repeated Measures ANOVA (Tests of within-Subject Effects)
Anterior

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	55.792	2	27.896	1.525	.234
	Greenhouse-Geisser	55.792	1.379	40.446	1.525	.238
	Huynh-Feldt	55.792	1.474	37.863	1.525	.238
	Lower-bound	55.792	1.000	55.792	1.525	.236
Error(Tape)	Sphericity Assumed	548.875	30	18.296		
	Greenhouse-Geisser	548.875	20.691	26.527		
	Huynh-Feldt	548.875	22.103	24.833		
	Lower-bound	548.875	15.000	36.592		

Anterior Medial

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	47.042	2	23.521	2.061	.145
	Greenhouse-Geisser	47.042	1.792	26.252	2.061	.151
	Huynh-Feldt	47.042	2.000	23.521	2.061	.145
	Lower-bound	47.042	1.000	47.042	2.061	.172
Error(Tape)	Sphericity Assumed	342.292	30	11.410		
	Greenhouse-Geisser	342.292	26.879	12.735		
	Huynh-Feldt	342.292	30.000	11.410		
	Lower-bound	342.292	15.000	22.819		

Medial

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	3.125	2	1.562	.156	.856
	Greenhouse-Geisser	3.125	1.807	1.729	.156	.836
	Huynh-Feldt	3.125	2.000	1.562	.156	.856
	Lower-bound	3.125	1.000	3.125	.156	.698
Error(Tape)	Sphericity Assumed	300.208	30	10.007		
	Greenhouse-Geisser	300.208	27.112	11.073		
	Huynh-Feldt	300.208	30.000	10.007		
	Lower-bound	300.208	15.000	20.014		

Posteromedial

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	64.542	2	32.271	2.620	.089
	Greenhouse-Geisser	64.542	1.919	33.633	2.620	.092
	Huynh-Feldt	64.542	2.000	32.271	2.620	.089
	Lower-bound	64.542	1.000	64.542	2.620	.126
Error(Tape)	Sphericity Assumed	369.458	30	12.315		
	Greenhouse-Geisser	369.458	28.785	12.835		
	Huynh-Feldt	369.458	30.000	12.315		
	Lower-bound	369.458	15.000	24.631		

Posterior

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	59.375	2	29.688	2.443	.104
	Greenhouse-Geisser	59.375	1.979	29.996	2.443	.105
	Huynh-Feldt	59.375	2.000	29.688	2.443	.104
	Lower-bound	59.375	1.000	59.375	2.443	.139
Error(Tape)	Sphericity Assumed	364.625	30	12.154		
	Greenhouse-Geisser	364.625	29.692	12.280		
	Huynh-Feldt	364.625	30.000	12.154		
	Lower-bound	364.625	15.000	24.308		

Posterolateral

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	181.500	2	90.750	5.738	.008
	Greenhouse-Geisser	181.500	1.413	128.494	5.738	.017
	Huynh-Feldt	181.500	1.516	119.713	5.738	.015
	Lower-bound	181.500	1.000	181.500	5.738	.030
Error(Tape)	Sphericity Assumed	474.500	30	15.817		
	Greenhouse-Geisser	474.500	21.188	22.395		
	Huynh-Feldt	474.500	22.742	20.865		
	Lower-bound	474.500	15.000	31.633		

Lateral

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	435.375	2	217.688	7.978	.002
	Greenhouse-Geisser	435.375	1.355	321.362	7.978	.006
	Huynh-Feldt	435.375	1.442	301.923	7.978	.005
	Lower-bound	435.375	1.000	435.375	7.978	.013
Error(Tape)	Sphericity Assumed	818.625	30	27.288		
	Greenhouse-Geisser	818.625	20.322	40.283		
	Huynh-Feldt	818.625	21.630	37.847		
	Lower-bound	818.625	15.000	54.575		

Anterolateral

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Tape	Sphericity Assumed	78.167	2	39.083	1.918	.164
	Greenhouse-Geisser	78.167	1.714	45.610	1.918	.172
	Huynh-Feldt	78.167	1.913	40.854	1.918	.167
	Lower-bound	78.167	1.000	78.167	1.918	.186
Error(Tape)	Sphericity Assumed	611.167	30	20.372		
	Greenhouse-Geisser	611.167	25.707	23.774		
	Huynh-Feldt	611.167	28.700	21.295		
	Lower-bound	611.167	15.000	40.744		

Bonferroni Post-Hoc Test (Pairwise Comparisons)

Key
1 – No Tape
2 – Rigid Tape
3 – Kinesiology Tape

Anterior

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-.188	1.560	1.000	-4.391	4.016
	3	-2.375	.944	.071	-4.917	.167
2	1	.188	1.560	1.000	-4.016	4.391
	3	-2.188	1.880	.788	-7.252	2.877
3	1	2.375	.944	.071	-.167	4.917
	2	2.188	1.880	.788	-2.877	7.252

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Anterior Medial

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	2.000	1.144	.302	-1.081	5.081
	3	-.188	1.038	1.000	-2.983	2.608
2	1	-2.000	1.144	.302	-5.081	1.081
	3	-2.188	1.376	.398	-5.894	1.519
3	1	.188	1.038	1.000	-2.608	2.983
	2	2.188	1.376	.398	-1.519	5.894

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Medial

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.625	.948	1.000	-1.929	3.179
	3	.313	1.117	1.000	-2.696	3.321
2	1	-.625	.948	1.000	-3.179	1.929
	3	-.313	1.267	1.000	-3.726	3.101
3	1	-.313	1.117	1.000	-3.321	2.696
	2	.313	1.267	1.000	-3.101	3.726

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Posteromedial

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	-1.063	1.318	1.000	-4.613	2.488
	3	-2.813	1.108	.068	-5.796	.171
2	1	1.063	1.318	1.000	-2.488	4.613
	3	-1.750	1.286	.581	-5.215	1.715
3	1	2.813	1.108	.068	-.171	5.796
	2	1.750	1.286	.581	-1.715	5.215

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Posterior

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.313	1.290	1.000	-3.163	3.788
	3	-2.188	1.222	.281	-5.479	1.104
2	1	-.313	1.290	1.000	-3.788	3.163
	3	-2.500	1.183	.155	-5.687	.687
3	1	2.188	1.222	.281	-1.104	5.479
	2	2.500	1.183	.155	-.687	5.687

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Posterolateral

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	.000	.866	1.000	-2.333	2.333
	3	-4.125*	1.513	.047	-8.202	-.048
2	1	.000	.866	1.000	-2.333	2.333
	3	-4.125	1.700	.085	-8.705	.455
3	1	4.125*	1.513	.047	.048	8.202
	2	4.125	1.700	.085	-.455	8.705

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Lateral

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	2.813	1.145	.080	-.271	5.896
	3	-4.500	1.882	.091	-9.569	.569
2	1	-2.813	1.145	.080	-5.896	.271
	3	-7.313*	2.320	.020	-13.561	-1.064
3	1	4.500	1.882	.091	-.569	9.569
	2	7.313*	2.320	.020	1.064	13.561

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Anterolateral

Pairwise Comparisons

Measure: MEASURE_1

(I) Tape	(J) Tape	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	1.500	1.393	.896	-2.254	5.254
	3	-1.625	1.455	.844	-5.543	2.293
2	1	-1.500	1.393	.896	-5.254	2.254
	3	-3.125	1.893	.358	-8.223	1.973
3	1	1.625	1.455	.844	-2.293	5.543
	2	3.125	1.893	.358	-1.973	8.223

Based on estimated marginal means

a. Adjustment for multiple comparisons: Bonferroni.

Table to Highlight the value used within Literature

	Sphericity	Spericity Assumed	Greenhouse-Geisser	F Value
Anterolateral	0.278	0.164	0.172	1.918
Anterior	0.015	0.234	0.238	1.525
Anteromedial	0.421	0.145	0.151	2.061
Medial	0.455	0.856	0.836	0.156
Posteromedial	0.739	0.089	0.092	2.62
Posterior	0.93	0.104	0.105	2.443
Posterolateral	0.023	0.008	0.017	5.738
Lateral	0.011	0.002	0.006	7.978

APPENDIX D

Data Collected on Excel

No Tape – Best Scores Achieved for each Participant

Participant	AL	A	AM	M	PM	P	PL	L
1	78	80	86	88	90	94	87	88
2	68	68	70	72	76	74	62	60
3	70	80	81	76	74	69	66	63
4	75	77	80	78	93	96	90	77
5	67	70	79	75	72	78	70	59
6	61	68	74	73	73	77	65	50
7	65	73	69	77	82	87	79	71
8	63	69	75	80	87	86	78	72
9	69	68	70	70	72	73	71	67
10	72	73	75	75	82	74	71	66
11	83	82	77	76	85	79	81	71
12	72	80	86	86	85	83	82	74
13	76	73	75	75	79	85	79	68
14	83	75	83	83	88	87	78	69
15	70	70	81	81	88	88	85	78
16	84	76	82	82	88	89	85	80

Rigid Tape – Best Scores Achieved for each Participant

Participant	AL	A	AM	M	PM	P	PL	L
1	80	82	84	87	97	93	92	78
2	69	69	75	76	80	74	61	55
3	71	83	86	79	83	72	65	60
4	69	74	75	76	80	85	86	71
5	63	65	69	67	76	76	69	54
6	59	68	68	74	77	76	66	49
7	63	72	70	75	80	80	74	64
8	64	70	75	79	88	85	80	71
9	63	63	69	72	74	82	73	61
10	67	78	78	74	80	72	76	66
11	82	79	80	81	86	88	83	67
12	70	77	82	84	90	87	82	73
13	72	64	68	67	75	80	71	61
14	79	79	81	81	86	89	81	74
15	86	89	76	79	86	88	85	86
16	75	73	75	86	93	87	85	78

Kinesiology Tape – Best Scores Achieved for each Participant

Participant	AL	A	AM	M	PM	P	PL	L
1	87	83	85	91	101	96	94	87
2	78	74	67	61	72	69	77	75
3	83	85	85	77	82	75	81	77

4	74	79	83	75	92	95	90	80
5	62	74	73	71	75	75	71	66
6	62	74	79	77	79	80	75	75
7	67	74	79	77	79	80	75	75
8	69	75	77	78	90	89	83	73
9	72	70	70	73	79	86	82	72
10	68	74	73	72	82	75	67	68
11	79	74	75	77	84	82	84	69
12	79	83	83	84	86	88	1	75
13	76	76	77	74	87	93	84	68
14	80	82	84	83	90	91	80	70
15	65	68	75	80	87	88	84	74
16	81	75	81	92	94	92	87	81

Average Distance Achieved for each Direction of SEBT

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
Anterolateral	72.25	70.75	73.88
Anterior	73.88	74.06	76.25
Anteromedial	77.69	75.69	77.88
Medial	77.94	77.31	77.63
Posteromedial	82.13	83.19	84.94
Posterior	82.44	82.13	84.63
Posterolateral	76.81	76.81	80.94
Lateral	69.56	66.75	74.06

Data Collected on Excel

No Tape – Best Scores Achieved for each Participant

Participant	AL	A	AM	M	PM	P	PL	L
1	78	80	86	88	90	94	87	88
2	68	68	70	72	76	74	62	60
3	70	80	81	76	74	69	66	63
4	75	77	80	78	93	96	90	77
5	67	70	79	75	72	78	70	59
6	61	68	74	73	73	77	65	50
7	65	73	69	77	82	87	79	71
8	63	69	75	80	87	86	78	72
9	69	68	70	70	72	73	71	67
10	72	73	75	75	82	74	71	66
11	83	82	77	76	85	79	81	71
12	72	80	86	86	85	83	82	74
13	76	73	75	75	79	85	79	68
14	83	75	83	83	88	87	78	69
15	70	70	81	81	88	88	85	78
16	84	76	82	82	88	89	85	80

Rigid Tape – Best Scores Achieved for each Participant

Participant	AL	A	AM	M	PM	P	PL	L
1	80	82	84	87	97	93	92	78
2	69	69	75	76	80	74	61	55
3	71	83	86	79	83	72	65	60
4	69	74	75	76	80	85	86	71
5	63	65	69	67	76	76	69	54
6	59	68	68	74	77	76	66	49
7	63	72	70	75	80	80	74	64
8	64	70	75	79	88	85	80	71
9	63	63	69	72	74	82	73	61
10	67	78	78	74	80	72	76	66
11	82	79	80	81	86	88	83	67
12	70	77	82	84	90	87	82	73
13	72	64	68	67	75	80	71	61
14	79	79	81	81	86	89	81	74
15	86	89	76	79	86	88	85	86
16	75	73	75	86	93	87	85	78

Kinesiology Tape – Best Scores Achieved for each Participant

Participant	AL	A	AM	M	PM	P	PL	L
1	87	83	85	91	101	96	94	87
2	78	74	67	61	72	69	77	75
3	83	85	85	77	82	75	81	77
4	74	79	83	75	92	95	90	80
5	62	74	73	71	75	75	71	66
6	62	74	79	77	79	80	75	75
7	67	74	79	77	79	80	75	75
8	69	75	77	78	90	89	83	73
9	72	70	70	73	79	86	82	72
10	68	74	73	72	82	75	67	68
11	79	74	75	77	84	82	84	69
12	79	83	83	84	86	88	1	75
13	76	76	77	74	87	93	84	68
14	80	82	84	83	90	91	80	70
15	65	68	75	80	87	88	84	74
16	81	75	81	92	94	92	87	81

Average Distance Achieved for each Direction of SEBT

	No Tape (cm)	Rigid Tape (cm)	Kinesiology Tape (cm)
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Posterior	82.44	82.13	84.63
Posterolateral	76.81	76.81	80.94
Lateral	69.56	66.75	74.06